Review of Cabaj et al. "Investigating the impact of reanalysis snow input on an observationally calibrated snow-on-sea-ice reconstruction"

This study aims to investigate the impact of different reanalysis snow input in snow-on-sea-ice reconstructions (snow depth and density) provided by NASA's Eulerian Snow On Sea Ice Model (NESOSIM) (Petty et al., 2018). In an earlier study by Cabaj et al. (2023) wind packing and blowing snow parameters were calibrated in NESOSIM using a Markov chain Monte Carlo (MCMC) approach, with ERA5 snowfall. The same MCMC approach is used here, with snowfall inputs from additional reanalysis (MERRA-2 and JRA-55). All reanalysis snowfall was first calibrated to CloudSat following Cabaj et al. (2020). The impact of the MCMC calibration to NESOSIM and the snow depth and density uncertainties are assessed and discussed. NESOSIM outputs of snow depth and density are regionally compared to SnowModel-LG (Liston et al., 2020), a Langragian snow evolution modeling system for sea ice applications. Pan-Arctic and regional monthly trends of snow depth, density and volume derived from both NESOSIM and SnowModel-LG are examined and discussed.

The paper addresses scientific questions within the scope of TC. The title reflects the contents and the abstract provides a concise summary of the study. The overall presentation of the paper is well-structured and the language is clear and coherent. However, while the central findings and conclusions are supported by the data, there are areas where the manuscript would benefit from additional context and clarification. My recommendation is to reconsider the paper after major revisions, to improve its overall quality and precision.

Major comments:

1. NESOSIM and MCMC calibration
Attention should be payed in this section to ensure a coherent description of the methodology used for calibrating the parameters, so that the method can be repeated by anyone to reproduce the results. Some examples are given:
- Line 145: Rewrite into "MCMC is an algorithm applied to Bayesian problems where, given prior information of the parameters…"
- Line 147: "in this case, a log-likelihood function". Function of what?
- Line 149: Replace "prior" with "initial"? In Bayesian problems "prior" refers to a distribution, when in your case you provide a single value. Same in the caption of Figure 3.
- Line 152: "with step size chosen from the distribution". Need to be more specific.
- Equation 1: You can add the uncertainty related to errors of representativeness of the observations, in each term of the equation.
- Line 174: "all distributions are assumed to be Gaussian". Specify which distributions.
- Figure 3. Discuss why we see correlation between the properties, especially in JRA-55.

2. The scaling issue and the sub-grid variability of the snow properties is not discussed enough in the paper. More attention should be paid in this, especially as point measurements of density are used in the calibration.

3. Why do you use ERA5 wind in all runs? Consider using wind inputs from different reanalysis data to investigate their effect in the calibration.

4. You compare post calibration results from NESOSIM to SnowModel-LG but not to independent measurements like passive microwave products or airborne campaigns (OIB/IceBird). Adding comparison to independent measurements will strengthen the study. Regarding the comparison of NESOSIM to SnowModel-LG you should consider the effect of Eulerian (NESOSIM) vs. Langragian (SnowModel-LG) approach when discussing the differences between the model results. Is SnowModel-LG also forced with CloudSat scaled reanalysis forcing? If not, this is another aspect that needs to be emphasized and discussed.

5. Why does the analysis stop in 2019? Consider extending to 2022, so MOSAiC observations can be included in the MCMC calibration.

Minor comments:

1. Need to specify the blowing snow parameter better. I assume it refers to a snow loss term to the atmosphere (i.e., sublimation) and the open ocean. Make clear that snow is not blown from one 100 km x 100 km grid to another.

2. Figures 4 and 5 include only one season. Consider an inter-annual average monthly evolution plot for all properties and their uncertainties.